

Multi-Jurisdictional Local Government Hazard Mitigation Plan For the San Francisco Bay Area

City and County of San Francisco Annex

April 2005

Introduction

San Francisco is the fourth largest city in California, with a population of 776,733 (based on the 2000 census). With a land area of 47 square miles, the population density is 16,526 persons per square mile. San Francisco is both a city and a county, with an annual budget of over \$5 billion and more than 28,000 city and county government employees. There are 329,700 occupied units of housing, of which 35% are owner-occupied and 65% are renter-occupied.

Planning Process

The City and County of San Francisco has been conducting local hazard mitigation projects and planning activities for many years, with the heaviest emphasis occurring over the last 16 years. Shortly after the Loma Prieta Earthquake of October 17, 1989, the Board of Supervisors formed a Special Earthquake Recovery Committee, which devoted many hours to hearing from concerned citizens and department heads about damage caused by the earthquake and ways to mitigate future potential damage. The Hazard Mitigation Plan which resulted from that recovery effort was published in 1990 and reflected much of the public testimony offered to the committee.

One of the recommendations of the 1990 Hazard Mitigation Plan was to revise the Community Safety Element of the Master Plan, which had been adopted by the City Planning Commission in 1974. The process of preparing the updated Community Safety Element began in 1992, when the first of two background reports, "Review of Seismic Information," was published. That report described the earthquake risks facing San Francisco as a result of its geology, soils and structures. It summarized studies and assessments of the likely impacts of future earthquakes that were prepared by others. In 1993 a second report, "Earthquake Safety Programs," described the public and private programs that have been developed to lessen and respond to those risks, focusing on programs within the City and County of San Francisco. The revised Community Safety Element was completed and adopted in 1997.

The City and County of San Francisco also maintains an Emergency Operations Plan (EOP), which covers the response to and recovery from disasters and other emergencies in San Francisco. Mitigation and preparedness activities are addressed in this plan, as well as hazards and risks facing San Francisco. The EOP released in 1987 was revised in 1996 to incorporate California's Standardized Emergency

Management System (SEMS), then revised again in 2004. Hazard mitigation plans and strategies are also addressed in the EOP. Throughout a public comment period, citizens and others were able to offer suggestions and comments on the Basic Plan, including mitigation efforts and plans. In addition, the mitigation planning process has been discussed at four recent Disaster Council meetings, which are open to the public and have public comment opportunities.

The Community Action Plan for Seismic Safety (CAPSS) Project was initiated by the Department of Building Inspection in 2000 to evaluate seismic risk in San Francisco and to conduct public meetings to obtain input on proposed approaches for reducing these risks. The project team identified three main tasks:

- Form a Project Advisory Committee representing a range of community interests. Community interviews were conducted to gather input on what issues the CAPSS Project should address.
- Develop a loss estimate. In order for the City and County of San Francisco to understand the nature and magnitude of potential losses it might sustain in a major earthquake, the CAPSS team used FEMA's HAZUS loss estimation computer program along with San Francisco-specific seismological, geotechnical, structural and population data.
- Develop repair standards. The CAPSS project initiated the development of a standardized framework for the requirements of earthquake damage repair.

A fourth task of the CAPSS project was planned: the development of a long-term mitigation plan for the City and County of San Francisco, based on the results of the loss estimate.

The CAPSS project issued a draft report, *San Francisco's Earthquake Risk*, which includes a detailed loss estimate as described above. Additional work is needed to complete the CAPSS project. Strategies and funding sources have been identified to continue the process, and members of the Board of Supervisors have offered support to make this happen.

Hazard and Risk Assessment

The ABAG multi-jurisdictional Local Hazard Mitigation Plan, to which this is an annex, lists nine hazards that impact the Bay Area; five related to earthquakes (faulting, shaking, earthquake-induced landslides, liquefaction, and tsunamis) and four related to weather (flooding, landslides, wildfires, and drought). All of the listed hazards impact the City and County of San Francisco except fault surface rupture. No active faults occur in San Francisco. In addition, tsunamis can impact the coastline of San Francisco, but as indicated in the ABAG multi-jurisdictional plan and by the California Office of Emergency Services, the existing map is only appropriate for evacuation planning, not for mitigation planning.

Earthquakes

In the Hazard Identification section of the Emergency Operations Plan (EOP) for the City and County of San Francisco, the following information on earthquake hazards and

potential impact references the CAPPS project. The report is currently in draft form and this section of the EOP will be updated to reflect any changes in the final version of the CAPPS report.

The U.S. Geological Survey estimates a probability of two chances in three that a damaging earthquake will occur in the Bay Area within the next 30 years. In order to estimate earthquake impacts, the CAPSS team used the computer program HAZUS, an earthquake loss-estimation program developed by FEMA, together with San Francisco-specific seismological, geotechnical, structural and population data. HAZUS is accepted by FEMA and California OES as the standard for developing earthquake loss estimations.

Four realistic earthquake scenarios were selected for study: magnitude 7.9, 7.2 and 6.5 events on the San Andreas fault, which passes by San Francisco just offshore at Lake Merced, and a magnitude 6.9 event on the Hayward fault in Oakland and Berkeley. The foot of Market Street in downtown San Francisco is about 10 miles from both the San Andreas and Hayward faults.

Damage and loss estimates were developed separately for shaking-related damage and fire-related damage. Shaking-related damage includes damage caused by soil liquefaction during the earthquake. The table below summarizes the shaking-related damage in each of the four scenario earthquakes. The shaking-related damage could be substantial – 29 percent of the City’s building value (\$53 billion, based on typical replacement cost) would be destroyed by shaking effects in a repeat of the 1906 earthquake and 18 percent in the magnitude 7.2-scenario earthquake (about the same size as the 1989 Loma Prieta earthquake, but located closer to the City). For the magnitude 7.2 event, assuming a resident population of 772,000, this equates to an immediate economic impact of about \$12,500 per capita. About half of this damage would be to the City’s housing stock and most of this would occur in so called soft-story buildings, which make up a large fraction of the City’s residential building stock. A soft story in a building is a story that is substantially weaker and more flexible in the horizontal direction than other stories. San Francisco has many buildings with a soft first story due to garage door openings or extensive window openings at street level.

The following table summarizes the total economic losses from each scenario earthquake, including losses arising from business interruption, lost wages, lost rental income and the costs of relocation. Fires following the earthquake were the cause of 80 percent of the total losses in San Francisco in 1906 and fire continues to be a major risk for San Francisco today.

Scenario Earthquakes	Building Damage (\$ Billions)	Percent of Total Building Value*
San Andreas Magnitude 7.9	\$ 15.3	29%
San Andreas Magnitude 7.2	9.7	18%
San Andreas Magnitude 6.5	6.2	12%
Hayward Magnitude 6.9	4.4	8%
Total Economic Losses (\$ Billions)		
San Andreas Magnitude 7.9	\$ 24.7	
San Andreas Magnitude 7.2	15.9	
San Andreas Magnitude 6.5	10.1	
Hayward Magnitude 6.9	7.3	

* Total Building Value; \$ 53.3 billion

Summary Economic Impacts - Shaking Only

The following table summarizes the projected losses from the combined effects of earthquake shaking and post-earthquake fire. When both sources of damage are considered, the average losses are 50 percent to 100 percent higher. The estimates for fire consider, on a probability-weighted basis, the likelihood of no wind, low wind, average wind and high wind conditions.

Neighborhood	TOTAL VALUE (\$ Millions)	San Andreas Magnitude 6.5		San Andreas Magnitude 7.2		San Andreas Magnitude 7.9		Hayward Magnitude 6.9	
		Damage (\$Millions)	% of Total	Damage (\$Millions)	% of Total	Damage (\$Million s)	% of Total	Damage (\$Million s)	% of Total
Bayview	\$1,569	\$248	16%	\$356	23%	\$547	35%	\$212	13%
Downtown, South of Market, Civic Center	\$14,160	\$3,281	23%	\$4,179	30%	\$5,848	41%	\$3,401	24%
Excelsior	\$4,195	\$661	16%	\$957	23%	\$1,253	30%	\$387	9%
Ingleside	\$959	\$235	24%	\$325	34%	\$410	43%	\$89	9%
Marina	\$908	\$240	26%	\$273	30%	\$340	37%	\$230	25%
Merced	\$484	\$115	24%	\$164	34%	\$204	42%	\$36	7%
Mission, Castro, Glen Park, Noe Valley	\$5,934	\$814	14%	\$1,238	21%	\$1,866	31%	\$690	12%
Mission Bay, South Beach, Potrero Hill	\$2,695	\$464	17%	\$574	21%	\$857	32%	\$451	17%
North Beach	\$3,633	\$556	15%	\$696	19%	\$1,095	30%	\$601	17%
Pacific Heights	\$2,735	\$366	13%	\$564	21%	\$832	30%	\$357	13%
Richmond	\$3,918	\$708	18%	\$1,050	27%	\$1,352	35%	\$384	10%
Sunset	\$5,033	\$1,313	26%	\$1,702	34%	\$2,051	41%	\$588	12%
Twin Peaks	\$2,009	\$385	19%	\$572	28%	\$778	39%	\$197	10%
Western Addition	\$5,063	\$657	13%	\$1,023	20%	\$1,509	30%	\$550	11%
Total	\$53,295	\$10,044	19%	\$13,674	26%	\$18,942	36%	\$8,173	15%

Estimates of fire damage are more uncertain because weather conditions, especially wind, are major factors in the size of fires. Under adverse meteorological conditions and high winds, losses from fires following an earthquake can be much larger than indicated.

All of these earthquakes would also result in substantial displacement, estimated at 30,000 displaced households in the San Andreas 7.2 event. Secondary economic impacts would also be substantial, with, for example, \$2 billion in annual retail sales being lost to the private sector, with corresponding reductions in the City's sales tax revenues.

This impact analysis only addresses those buildings under the purview of the Department of Building Inspection; many structures and facilities in San Francisco were not analyzed in this study. For example, public buildings (public schools; City, State and Federal buildings; and port facilities) and infrastructure (water, sewer, power, gas, transportation, bridges, piers and tunnels) were not included. Data were not collected on these structures and damage was not estimated. The study also did not address the negative impact on people and the economy resulting from damage to these facilities or their loss of function

Fire or Conflagration

The City and County of San Francisco has also identified the threat of a large fire of conflagration within its boundaries. A conflagration is defined as a fire incident with a front of at least 300 feet or when a fire has jumped across a natural barrier. Congestion, density, mix of dwellings and businesses and light industry are factors that contribute to the potential for an urban conflagration.

Urban areas have been the site of conflagrations during the past century. The great 1906 earthquake resulted in a major conflagration that destroyed most of the CCSF. More recently, wildland fires have destroyed residential areas situated adjacent to undeveloped lands.

In San Francisco, the following areas are vulnerable to conflagration because of congestion, construction type, density of structures and narrow streets:

- The Financial District is highly congested with high-rise structures and large office complexes. These buildings present severe exposure to one another. They are generally located in the fill and infirm soil areas of the CCSF and their foundation structures are typically pile-supported. In a major earthquake, a severe fire hazard could be generated by the loss of water supply to sprinkler and other fire protection systems in the high-rise structures. Very high afternoon winds, which would exacerbate any fire, occur in the area each day because of the canyon effect the crowded buildings create in the District.

This District includes 406 acres in the extreme northeastern part of the CCSF and includes the following streets: beginning at Mission Street and the Embarcadero, Mission, Beale, Howard, Third, Minna, Fifth, Sixth, Stevenson, Seventh, Market, Jones, Golden Gate, Taylor, Post, Powell, Bush, Grant, Pine, Annie, California, Kearny, Jackson, Montgomery, Pacific, Sansome, Broadway, Front, Jackson, Davis, Washington, Drumm, Clay and the Embarcadero.

- The high population density and narrow streets of the Chinatown and the Tenderloin make these downtown neighborhoods high-risk for conflagration. Such residential areas of the CCSF with their high density of wood structures in close proximity to each other and with garages under living units also pose a threat. Overhead electric lines in CCSF neighborhoods are potential problems as is an aging, underground, natural gas distribution system.

Chinatown is bounded on the east and south by the Financial District and Pine Street. It extends north to and includes Broadway, Union and Powell. Stockton Street is the general western boundary. The Tenderloin District is bounded by Geary, Stockton, Market, Leavenworth, Golden Gate and Polk Streets.

Urban–Wildland Interface. There is not a major threat of an urban-wildland conflagration within the CCSF. However, the potential for an urban-wildland interface conflagration exists in the following locations:

- The Presidio (Federal property)
- Yerba Buena Island
- Golden Gate Park
- McLaren Park
- Glen Canyon Park
- Sigmund Stern Grove

A conflagration in an area that is surrounded by residential structures poses a serious threat to lives and property.

While the City and County of San Francisco has undertaken a number of general hazard mapping activities since the first Safety Element was prepared, all of these maps are less detailed and are not as current as those shown on the ABAG website at <http://quake.abag.ca.gov/mitigation/>

Information on disasters declared in San Francisco County is at: <http://quake.abag.ca.gov/mitigation/disaster-history.html>

The City and County of San Francisco examined the hazard exposure of San Francisco's urban land based on the information on ABAG's website at <http://quake.abag.ca.gov/mitigation/pickdbh2.html/>. Of the 29,187 urban acres in San Francisco,

- 23,097 acres are in the highest two categories of earthquake shaking potential;
- 14,566 acres are in areas of moderate, high or very high liquefaction susceptibility;
- 920 acres are in areas mapped as subject to special study requirements due to the potential for earthquake-induced landsliding by the California Geological Survey;
- 282 acres are in areas of existing landslides;
- 668 acres are subjected to high or very high wildfire threat, but 13,882 acres are in wildland-urban interface threat areas.
- 1,784 acres are subject to dam (reservoir) inundation.
- The City and County have not been mapped for flooding hazards by FEMA.
- Drought could impact the entire City and County.

The City and County of San Francisco also examined the hazard exposure of infrastructure based on the information on ABAG's website at <http://quake.abag.ca.gov/mitigation/pickdbh2.html>. Of the 1,137 miles of roadway in San Francisco,

- 896 miles of roadway are in the highest two categories of shaking potential;
- 553 miles of roadway are in areas of moderate, high, or very high liquefaction susceptibility;
- 9 miles of roadway are in areas mapped as subject to special study requirements due to the potential for earthquake-induced landsliding by the California Geological Survey;
- 196 miles of roadway are in areas of existing landslides;
- While no miles of roadway are subject to high, very high, or extreme wildfire threat, 499 miles of roadway are in wildland-urban interface threat areas;
- 69 miles of roadway are in areas subject to dam (reservoir) inundation.
- The City and County have not been mapped for flooding hazards by FEMA.
- Drought could impact the entire City and County.

Finally, the City and County of San Francisco examined the hazard exposure of critical health care facilities, schools, and city-owned buildings based on the information on ABAG's website at <http://quake.abag.ca.gov/mitigation/pickcrit.html>. Of the critical facilities in San Francisco,

- 81 health care facilities, 175 schools, and 431 city/county-owned critical facilities are in areas within the highest two categories of earthquake shaking potential;
- 58 health care facilities, 93 schools, and 268 city/county-owned critical facilities are in areas with moderate, high or very high liquefaction susceptibility.
- 0 health care facilities, 0 schools, and 2 city/county-owned critical facilities are in areas mapped as subject to special study requirements due to the potential for earthquake-induced landsliding by the California Geological Survey;
- No critical health care facilities, schools, or county-owned critical facilities are in areas of existing landslides;
- 28 health care facilities, 90 schools, and 155 city/county-owned critical facilities are in wildland-urban interface threat areas;

- 1 health care facility, 14 schools, and 13 city/county-owned critical facilities are in an area subject to dam (reservoir) inundation.
- The City and County have not been mapped for flooding hazards by FEMA.
- Drought could impact the entire City and County.

Even though San Francisco is not within a federal flood zone, four properties outside the flood plain are subject to repetitive flood loss, based on the ABAG information at <http://quake.abag.ca.gov/mitigation/pickflood.html>

Drought, though a potential problem in San Francisco, is not fully assessed. The City and County of San Francisco will be working with ABAG and the San Francisco PUC on this issue.

The City and County of San Francisco plans to work with ABAG during 2005 to improve the risk assessment information being compiled by ABAG by providing information on unreinforced masonry buildings and soft-story apartments located in San Francisco.

The City and County of San Francisco will work with ABAG in developing information about the impact of each hazard on buildings, infrastructure and critical facilities. ABAG's annex to the plan states that they will be compiling this data through 2005 and into early 2006. As these impacts are not fully developed, the City and County of San Francisco has reviewed the hazards identified and ranked the hazards based on past disasters and expected future impacts. The conclusion is that earthquakes (particularly shaking) are the most significant hazard.

Mitigation Activities and Priorities

As a participant in the ABAG multi-jurisdictional planning process, the City and County of San Francisco helped in the development and review of the comprehensive list of mitigation strategies in the overall multi-jurisdictional plan.

Over time, we are committed to developing better hazard and risk information to use in making those trade-offs. We are not trying to create a disaster-proof region, but a disaster-resistant one.

San Francisco provided information about its critical facilities to ABAG, and examined the hazard exposure information supplied by ABAG. For two of those sites a Pre-Disaster Mitigation Grant application was submitted to FEMA in the 2005 grant funding cycle. The PDM-C grant applications are for the following projects:

- Port of San Francisco Agriculture Building
Seismic upgrade to make the Agriculture Building earthquake resistant and, as part of San Francisco's downtown inter-modal transportation terminal, fully operational for emergency use in staging response personnel and serving as an emergency operations center.

- Moscone Club House/Recreation Center
Seismic upgrade to this facility in San Francisco's vulnerable Marina District will make it available for use as an emergency shelter and as a site for distribution of emergency supplies to affected residents.

At the meetings, all of the mitigation strategies were reviewed. The decision on priority was made based on a variety of criteria, not simply on an economic cost-benefit analysis. These criteria include being technically and administratively feasible, politically acceptable, socially appropriate, legal, economically sound, and not harmful to the environment or our historical heritage.

Plan Monitoring, Evaluation and Updating Process

The City and County of San Francisco is committed to reviewing and updating this plan annex at least once every five years, as required by the Disaster Mitigation Act of 2000. The Office of Emergency Services and Homeland Security will contact ABAG four years after this plan is approved to ensure that ABAG plans to undertake the plan update process. If so, the City and County of San Francisco again plans to participate in the multi-jurisdictional plan. If ABAG is unwilling or unable to act as the lead agency in the multi-jurisdictional effort, other counties and regional agencies will be contacted. The counties will then work together to identify another regional forum for updating the multi-jurisdictional plan.

The Office of Emergency Services and Homeland Security will monitor this annex on an ongoing basis. Triggers such as actual disasters affecting San Francisco, legislative changes, and notices from ABAG as the lead agency in this process will be used.

The public will continue to be involved whenever the plan is updated and as appropriate during the monitoring and evaluation process. For example, the Office of Emergency Services and homeland Security under the direction of the Mayor, convenes quarterly meetings of the Disaster Council. These meetings are advertised and open to the public. Additional public input opportunities will be scheduled as needed. All public comments will be reviewed, and suggestions and changes will be integrated into the plan updates as appropriate.